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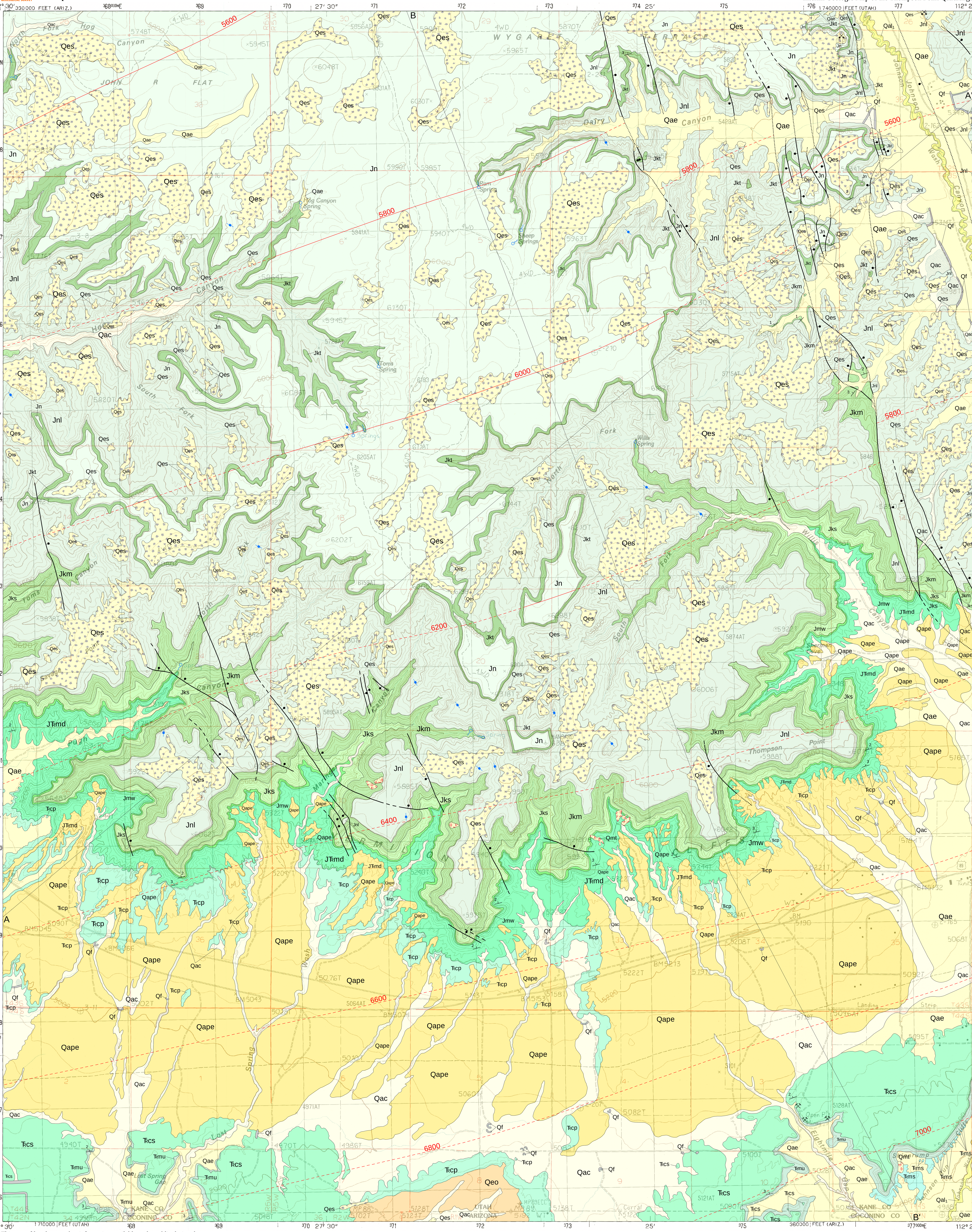

SCALE 1:24,000
Topographic Contour Interval 40 Feet
Structural Contour Interval 200 Feet

0 0.25 0.5 1 1.5 2 Miles

0 0.5 1 2 3 4 Kilometers

Base from U.S.G.S. Thompson Point (1987) 7.5' quadrangle
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1866

Project Manager: Bob Biek
GIS and Cartography: J. Buck Ehler

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Interim Geologic Map of the Thompson Point Quadrangle, Kane County, Utah and Coconino County, Arizona

by
Janice M. Hayden

2007

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Description of Map Units

QUATERNARY
Alluvial deposits

Qa — Shown in cross section only as a combination of mixed alluvial and eolian, alluvial and colluvial, and alluvial-pediment deposits.

Qal_1 — **Stream alluvium** (upper Holocene) – Moderately to well-sorted clay to boulder deposits in large, active drainages; mapped along Johnson Wash; includes terraces as much as 10 feet (3 m) above modern channels; 0 to 30 feet (0-9 m) thick.

Qape — **Alluvium and eolian pediment-mantle** (Holocene) – Unconsolidated to weakly consolidated clay- to small boulder-size debris that forms a pediment mantle, often with a thin cover of eolian sand and loess, principally on the non-resistant Petrified Forest Member of the Chinle Formation, but also on the Dinosaur Canyon Member of the Moenave Formation, at the base of the Vermilion Cliffs; portion next to cliffs still receives sediment and locally includes small, poorly sorted alluvial-fan, slope wash, and minor talus deposits; dissected and left as isolated remnants as much as 60 feet (18 m) above modern drainages; lower end merges with mixed alluvial-colluvial (Qac) and mixed alluvial-eolian (Qae) deposits; important local source of sand and gravel; 0 to 20 feet (0-6 m) thick.

Artificial deposits

Qf — **Artificial fill deposits** (Historical) – Artificial fill used to create small dams; consists of engineered fill and general borrow material; although only a few deposits have been mapped, fill should be anticipated in all areas with human impact, many of which are shown on the topographic base map; 0 to 20 feet (0-6 m) thick.

Eolian deposits

Qes — **Eolian sand** (Holocene) – Well- to very well sorted, very fine to medium-grained, well-rounded, mostly quartz sand derived principally from the Navajo Sandstone; commonly deposited in irregular hummocky mounds on the lee side of ridges, primarily on the Navajo Sandstone and gentle slopes of the Lamb Point Tongue of the Navajo Sandstone, but also deposited on mixed alluvial and eolian (Qae) deposits where side canyons widen near Johnson Canyon; 0 to 20 feet (0-6 m) thick.

Qeo — **Older eolian sand** (upper Pleistocene) – Calcic soil (caliche) caprock with lesser eolian sand that forms resistant, planar surface over less resistant beds of the Petrified Forest Member of the Chinle Formation near the middle of the south edge of the map area; 0 to 30 feet (0-9 m) thick.

Mass-movement deposits

Qmt — **Talus** (Holocene) – Very poorly sorted, angular boulders with minor fine-grained interstitial sediment; deposited mostly by rock fall on and at the base of steep slopes; form primarily from blocks that weather from the Navajo and Kayenta Formations and come to rest on the more gentle slope of the Moenave Formation and from blocks of Shinarump Conglomerate Member of the Chinle Formation that come to rest on the slope of the Moenkopi Formation; locally contain small landslide and slump deposits; may include and is gradational with older, alluvial-pediment-eolian deposits (Qape) farther downslope; mantles slopes beneath cliffs and ledges; 0 to 20 feet (0-6 m) thick.

Mixed-environment deposits

Qac — **Mixed alluvial and colluvial deposits** (Holocene) – Poorly to moderately sorted, clay- to boulder-sized, locally derived sediment deposited in swales and minor active drainages by fluvial, slope-wash, and creep processes; gradational with stream alluvium (Qal_1), alluvium and eolian pediment-mantle deposits (Qape), and mixed alluvial and eolian (Qae) deposits; 0 to 30 feet (0-9 m) thick.

Qae — **Mixed alluvial and eolian deposits** (Holocene to upper Pleistocene) – Moderately to well-sorted, clay- to sand-sized alluvial sediment that locally includes abundant eolian sand and minor alluvial gravel; calcic soils exhibit stage II pedogenic carbonate development (Birkeland and others, 1991); to the east of the quadrangle at Park Wash and Kitchen Corral Wash, radiocarbon ages from similar deposits indicate six depositional phases separated by periods of incision or nondeposition beginning at 6320, 5650, 5390, 4330, 2145, and 340 years before present (Sable and Hereford, 2004); upper reaches accumulate sediment, but deposits are deeply incised, thus exposing older depositional phases, by Johnson Wash just east of the quadrangle; includes alluvial fan deposits too small to map separately in the upper part; mapped along the west edge of the quadrangle where it extends into the area from beneath the City of Kanab, along the south edge, and along the east side of the quadrangle from Johnson Canyon; 0 to 90 feet (0-27 m) thick.

unconformity

JURASSIC
Navajo Sandstone and Kayenta Formation

Jn — **Navajo Sandstone main body** (Lower Jurassic) – Light-gray to pale-orange and moderate-reddish-orange to moderate-reddish-brown, massively cross-bedded, moderately well-cemented sandstone with well-rounded, fine- to medium-grained, frosted quartz sand grains; strongly jointed; forms the White Cliffs step of the Grand Staircase (Gregory, 1950); springs develop at lower contact with the Tenney Canyon Tongue of the Kayenta Formation; deposited in a vast coastal and inland dune field with prevailing winds principally from the north, and in rare interdunal ephemeral lakes and playas (Blakey, 1994; Peterson, 1994); lower contact is drawn where the massively bedded, vertically jointed sandstone gives way to the thinner bedded siltstone and sandstone of the Tenney Canyon Tongue of the Kayenta Formation; map unit includes areas of weathered sandstone regolith and Quaternary eolian sand too small to map separately; only lower 400 feet (120 m) is present in the quadrangle, but total thickness in this area is 1800 to 2000 feet (550-610 m) (Sargent and Philpott, 1987).

Jkt — **Tenney Canyon Tongue of Kayenta Formation** (Lower Jurassic) – Interbedded pale-reddish-brown siltstone, mudstone, and very fine grained, very thin bedded to laminated, quartz sandstone; slope former; deposited in a fluvial environment (Tuesink, 1989); conformably lies between the main body and the Lamb Point Tongue of the Navajo Sandstone, normally with sharp upper and lower contacts; however, locally, lenses of siltstone and mudstone are interbedded with sandstone typical of the Lamb Point Tongue near the base making the contact gradational; lower contact is placed where the thin, interbedded siltstone, mudstone, and sandstone above give way to the massively cross-bedded sandstone of the Lamb Point Tongue of the Navajo Sandstone; thickens westward from about 50 to 120 feet (15-40 m).

Jnl — **Lamb Point Tongue of Navajo Sandstone** (Lower Jurassic) – Grayish-white to grayish-orange, very fine to fine-grained, massively cross-bedded, quartz sandstone; locally includes thin interbeds of Tenney Canyon Tongue-like beds near the top; forms cliff; conformably lies between Tenney Canyon Tongue and main body of the Kayenta Formation; springs develop at the lower contact with the main body of the Kayenta Formation; lower contact is placed where the massively bedded, vertically jointed sandstone gives way to thinner bedded siltstone and sandstone; deposited in an eolian erg and sabkha environment (Tuesink, 1989); thickens northeastward across the quadrangle from about 300 to 450 feet (90-145 m).

Jkm — **Main body of Kayenta Formation** (Lower Jurassic) – Reddish-brown to moderate-reddish-brown to pale-red siltstone and mudstone interbedded with very fine to fine-grained sandstone; includes minor intraformational pebble conglomerate and thin beds of light-gray limestone; light-gray siltstone marker bed about 30 feet (9 m) below the top extends across the quadrangle; deposited in distal river, distal fluvial/playa, and minor lacustrine environments (Tuesink, 1989; Sansom, 1992; Blakey, 1994; Peterson, 1994); forms ledgy slope; thickness varies from about 200 to 350 feet (60-105 m).

Jks — **Springdale Sandstone Member of Kayenta Formation** (Lower Jurassic) – Mostly pale-reddish-purple to pale-reddish-brown, moderately sorted, fine- to medium-grained, medium- to very thick bedded sandstone, and minor, thin, discontinuous lenses of intraformational conglomerate and thin interbeds of moderate-reddish-brown or greenish-gray mudstone and siltstone; has large lenticular and wedge-shaped, low-angle, medium-to large-scale cross-bedding; secondary color banding that varies from concordant to discordant to cross-beds is common in the sandstone; weathers mostly to angular ledges along the Vermilion Cliffs, but locally forms more rounded cliffs that are typical of this member farther west; unconformable lower contact with the Whitmore Point Member of the Moenave Formation is placed at the base of the more massive, ledgy sandstone beds above the slope of interbedded mudstone and claystone; contains locally abundant petrified and carbonized fossil plant remains; deposited in braided-stream and minor flood-plain environments (DeCourten, 1998); generally thickens eastward but can locally thicken and thin abruptly; 100 to 250 feet (30-75 m) thick.

unconformity, J-sub Kayenta of Blakey (1994) and Marzolf (1994) who proposed a major regional unconformity at the base of the Springdale Sandstone, thus restricting the Moenave Formation to the Dinosaur Canyon and Whitmore Point Members. Subsequent work by Lucas and Heckert (2001), Molina-Garza and others (2003), and Lucas and Tanner (2007a) also suggested that the Springdale Sandstone is more closely related to, and should be made the basal member of, the Kayenta Formation.

JURASSIC/TRIASSIC
Moenave Formation

Jmw — **Whitmore Point Member (Lower Jurassic)** – Interbedded, pale-reddish-brown, greenish-gray, and grayish-red mudstone and claystone, with thin-bedded, moderate-reddish-brown, very fine to fine-grained sandstone and siltstone; siltstone is commonly thin bedded to laminated in lenticular or wedge-shaped beds; claystone is generally flat bedded; contains several 2- to 6-inch-thick (5-15 cm), bioturbated, cherty, very light gray to yellowish-gray, dolomitic limestone beds with algal structures, some altered to jasper, and fossil fish scales of *Semionotus kanabensis*; forms poorly exposed ledgy slope; to the west, the member consists of a lower and upper lacustrine interval separated by a red sandstone and siltstone ledge; eastward across the quadrangle, the lower lacustrine interval pinches out beneath the thickening red bed, resulting in a dramatic thinning of the unit; lower, conformable contact is placed at a pronounced break in slope at the base of the lowest light-gray, thin-bedded, dolomitic limestone and above the thicker bedded, reddish-brown sandstone and siltstone ledges of the Dinosaur Canyon Member; deposited in low-energy lacustrine and fluvial environments (DeCourten, 1998); thickens to the west from 15 to 40 feet (5-12 m).

JTRmd — **Dinosaur Canyon Member** (Lower Jurassic to Upper Triassic) – Uniformly colored, interbedded, generally thin-bedded, moderate-reddish-brown to moderate-reddish-orange, very fine to fine-grained sandstone, very fine grained silty sandstone, and lesser siltstone and mudstone; ripple marks and mud cracks common; forms ledgy slope that steepens eastward; forms the base of Vermilion Cliffs step of the Grand Staircase (Gregory, 1950); regionally, a thin chert pebble conglomerate marks the base of the unit, but in this area, it is more common to have a 1.5- to 2-foot-thick (0.5-0.6 m) gypsum bed with local chert pebbles; unconformable lower contact is placed at the base of the chert pebble conglomerate or gypsum bed where recognized, otherwise, it is placed at the prominent color and lithology change from reddish-brown siltstone above to pale-greenish-gray claystone of the Petrified Forest Member of the Chinle Formation below; deposited on broad, low flood plain that was locally shallowly flooded by water (fluvial mud flat) (DeCourten, 1998); thickness varies from 200 to 300 feet (60-90 m).

unconformity J-0 of Pipiringos and O'Sullivan (1978), who thought it was at the Jurassic-Triassic boundary; however, the Jurassic-Triassic boundary is now considered to be within the Dinosaur Canyon Member of the Moenave Formation (Molina-Garza and others, 2003; Lucas and Tanner, 2007b).

TRIASSIC
Chinle Formation

TRcp — **Petrified Forest Member** (Upper Triassic) – Highly variegated, light-brownish-gray, pale-greenish-gray, to grayish-purple bentonic shale, mudstone, siltstone, and claystone, with lesser thick-bedded, resistant sandstone and pebble to small cobble conglomerate near base; clasts are primarily chert and quartzite; contains minor chert, nodular limestone, and very thin coal seams and lenses as much as 0.5 inch (1 cm) thick; mudstone weathers to a "popcorn" surface due to expansive clays and causes road and building foundation problems; contains locally abundant, brightly colored, fossilized wood; weathers to badland topography; prone to landsliding along steep hillsides, however, outcrops within this quadrangle have fairly low relief; some of the best exposed outcrops are protected from erosion by older eolian deposits (Qeo) that form a resistant caprock; mostly slope forming; lower contact with the Shinarump Conglomerate Member of the Chinle Formation is placed at the base of the purplish-gray clay slope and above the prominent sandstone and conglomerate ledge; deposited in lacustrine, flood-plain, and braided-stream environments (Dubiel, 1994); not completely exposed within the quadrangle due to cover by Quaternary alluvium and eolian pediment-mantle deposits (Qape), alluvial-eolian (Qae) and alluvial-colluvial (Qac) deposits in the valley along the south edge of the quadrangle; thickness is 400 to 500 feet (130-165 m).

TRcs — **Shinarump Conglomerate Member** (Upper Triassic) – Varies from a dark-brown to a moderate-yellowish-brown, medium- to coarse-grained sandstone with locally well-developed limonite bands ("picture stone" or "landscape rock"), to a moderate-brown, pebbly conglomerate with subrounded clasts of quartz, quartzite, and chert; mostly thick to very thick bedded with both planar and low-angle cross-stratification, although thin, platy beds with ripple cross-stratification occur locally; strongly jointed with common slickensides; contains poorly preserved petrified wood, commonly replaced in part by iron-manganese oxides; locally, logs as much as 4 feet (1.2 m) long with a diameter of 2 feet (0.6 m) are found in place; forms a resistant ledge to small cliff above the Moenkopi Formation, thus capping the Chocolate Cliffs step of the Grand Staircase (Gregory, 1950); lower unconformable contact is drawn at the base of the small cliff above the slope-forming reddish-brown siltstone of the upper red member of the Moenkopi Formation; variable in composition and thickness because it represents stream-channel deposition over Late Triassic paleotopography (Dubiel, 1994); exposed along the south edge of the quadrangle with picture stone quarries in the southeast corner; thickness is 45 to 55 feet (14-17 m).

unconformity (TR-3) (Pipiringos and O'Sullivan, 1978)

Moenkopi Formation

TRmu — **Upper red member** (Middle? and Lower Triassic) – Interbedded moderate-reddish-brown, thin-bedded siltstone and mudstone and moderate-reddish-orange, thin- to medium-bedded sandstone with planar, low-angle, and ripple cross-stratification; contains some thin gypsum beds and abundant discordant gypsum stringers; well-preserved ripple marks common in the siltstone; forms ledgy slope and cliffs; overall, generally coarsens upward; lower conformable and gradational contact, marked by a prominent color change and lesser slope change, is placed at the top of the highest light colored, thick gypsum bed, above which are steeper slopes of laminated to thin-bedded, moderate-reddish-brown siltstone and sandstone of the upper red member; deposited in coastal-plain and tidal-flat environments (Dubiel, 1994); completely exposed only in the southeast corner of the quadrangle; 125 feet (40 m) thick (Doelling and Davis, 1989).

TRms — **Shnabkaib Member** (Lower Triassic) – Light-gray to pale-red, gypsiferous siltstone with bedded gypsum and several thin interbeds of dolomitic, unfossiliferous limestone near the base; upper part is very gypsiferous and weathers to a powdery soil commonly covered by microbiotic crust; forms ledge-slope "bacon-striped" topography; prone to landsliding; deposited on broad coastal shelf of very low relief where minor fluctuations in sea level produced interbedding of evaporites and red beds (Dubiel, 1994); only upper 80 feet (25 m) is exposed within the quadrangle; complete thickness in the area is 165 to 220 feet (50-65 m) (Doelling, 2007; Sable and Hereford, 2004).

Subsurface Unit

MzPzu — Mesozoic-Paleozoic, undivided – shown on cross section only.

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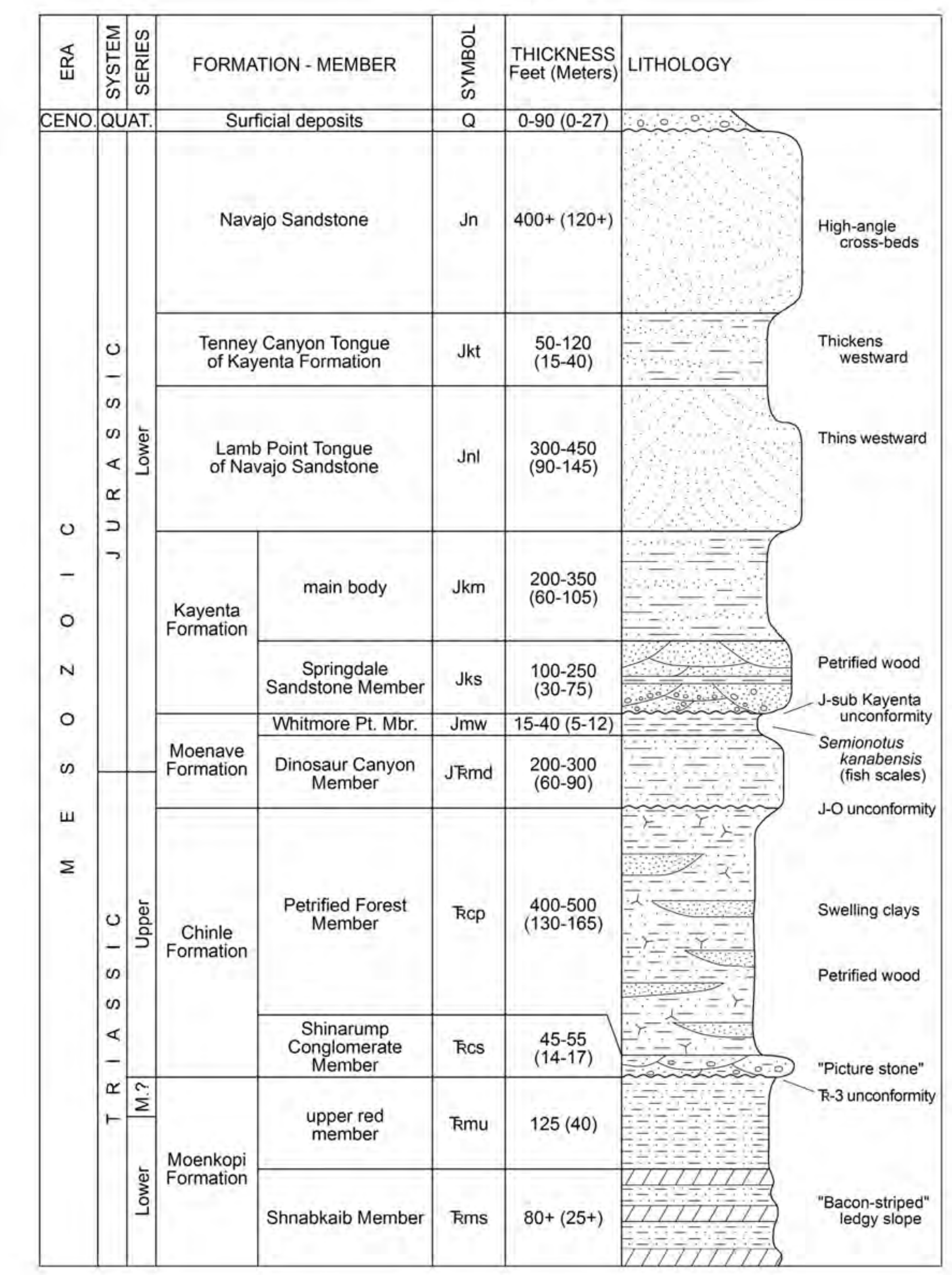
MAP SYMBOLS

- Contact, well located
- Fault, well located
- Fault, approximately located
- Fault, concealed
- Structural contour, well located
- Structural contour, projected
- Drawn on top of Jkt
- Contour interval = 200 ft
- 3 Strike and dip of bedding
- Joints - near vertical
- Gravel pit
- Quarry
- Spring
- A —— A' Cross section line

STRATIGRAPHIC COLUMN
Thompson Point 7.5' Quadrangle



CORRELATION OF GEOLOGIC UNITS
Thompson Point 7.5' Quadrangle